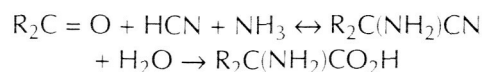


Amino Acids in Meteorites

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The Strecker synthesis,



has been proposed as a source of amino acids in meteorites. Detection in the Murchison meteorite of carbonyl compounds, the precursors of the amino acids in the Strecker synthesis, and of α -hydroxy acids, important by-products of the Strecker synthesis, supports this conjecture.

The amino acids and hydroxy acids found on Murchison are deuterium enriched, with $\delta\text{D} = +1751$ per mil for the unseparated amino acids, and $\delta\text{D} = +573$ per mil for the hydroxy acids. Several explanations consistent with a Strecker synthesis could account for this discrepancy, including the following: (1) It is generally accepted that the water responsible for the aqueous alteration that occurred on the Murchison parent body was deuterium-depleted with δD of the order of -100 per mil. If during synthesis, hydroxy acids retain less of the isotopic signature of their carbonyl precursors than their amino acid counterparts, or if the hydroxy acids exchange carbon-bonded hydrogens more rapidly with water than the corresponding amino acids, a lower δD for the hydroxy acids is to be expected, even if they and the amino acids arose from common precursors. (2) Individual pairs of α -amino acids and α -hydroxy acids arising from common precursors retain the isotopic signature of their precursors equally well, but the abundance of the amino acid in a particular amino acid-hydroxy acid pair relative to the total amino acids is different from the abundance of the corresponding hydroxy acid relative to that of the total hydroxy acids, resulting in quite different collective isotopic signatures for total amino acids and total hydroxy acids.

With the objective of determining if the discrepancy in deuterium enrichment between the amino

acids and the hydroxy acids found on Murchison is consistent with their formation in a Strecker synthesis, measurements have been made of the deuterium content of α -amino and α -hydroxy acids produced in solutions of deuterated carbonyl compounds, potassium cyanide (KCN) and ammonium chloride (NH_4Cl), and also in mixtures of such solutions and Allende dust at temperatures of 263 kelvin and 295 kelvin. Retention of the isotopic signature of the starting carbonyl by both α -amino acids and α -hydroxy acids is more dependent on temperature, concentration, and pH (a measure of acidity and alkalinity) than on the presence of meteorite dust in the solution. For acids with carbonyl precursors that have β -hydrogens, the retention of the isotopic signature of their carbonyl precursors is favored by high concentration, low pH, and low temperature. For such acids, loss of the isotopic signature of the carbonyl precursor is frequently greater for the amino acids than for the corresponding hydroxy acids. In order to determine if hydroxy acids retain their carbon-bonded hydrogens better than amino acids, deuterium exchange of α -hydroxy acids in deuterium oxide (D_2O) was investigated at temperatures in excess of 393 kelvin. No measurable loss of hydrogen was observed. Considerable deuterium exchange is observed for α -amino acids under such conditions. These results suggest that the Strecker synthesis is not responsible for the amino acids and hydroxy acids in the Murchison meteorite. In order to completely rule out the Strecker synthesis, the deuterium content of amino acid-hydroxy acid pairs such as glycine-glycolic acid or alanine-lactic acid need to be measured.

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